

The Effects of Multiple-Tact and Receptive-Discrimination Training on the Acquisition of Intraverbal Behavior

Caio F. Miguel, Anna Ingeborg Petursdottir, and James E. Carr
Western Michigan University

The purpose of this study was to determine whether multiple-tact training and receptive-discrimination training could be used to teach thematically related vocal intraverbals to typically developing preschool children. Multiple-tact training involved teaching a child to name both the item and the category to which the item belonged. Receptive-discrimination training consisted of teaching a child to select a picture card in the presence of a question from the experimenter regarding the item or its category. When neither of these strategies resulted in substantial increases in intraverbal responses, a typical intraverbal training protocol using tact prompts was implemented. Six typically developing children participated in the study. A multiple-baseline design across word categories was used to evaluate the effects of the three training procedures. Results indicated that both multiple-tact and receptive-discrimination training had minimal effects on the strength of the intraverbal repertoire, whereas direct intraverbal training had a more substantial effect. The results provide some evidence of the functional independence of verbal operants, as well as the independence of listener and speaker repertoires. Receptive-discrimination and multiple-tact training may have facilitated acquisition of intraverbals; however, further research is needed to assess how these repertoires might interact with each other.

Key Words: intraverbal, tact, receptive discrimination, verbal behavior, language development, and typically-developing children

In behavior analysis, language has been viewed as no different in its operative properties from other forms of behavior. The term “verbal behavior” has been used instead of language to suggest its environmental determination and move away from traditional structuralist approaches to language development. What sets verbal behavior apart from other forms of behavior is how reinforcement is achieved. In the case of verbal behavior, reinforcement is achieved through someone else’s

behavior, whereas with non-verbal behavior reinforcement is achieved directly through mechanical action (Skinner, 1957, p. 2). Thus, gesturing, signing, and writing could all be considered verbal given that reinforcement for these behaviors is usually obtained indirectly through another person. For example, one may obtain a cup of coffee through someone else’s behavior by pointing to a cup (verbal behavior) or by reaching for the cup (non-verbal behavior).

Skinner (1957) classified verbal behavior into several elementary relations based on their function; he referred to these relations as *verbal operants*. One of these operants is the *intraverbal*. Intraverbal behavior is defined as a type of verbal behavior controlled by a verbal stimulus (the product of someone else’s verbal behavior) in which there is no point-to-point correspondence between the stimulus and the response (p. 71). In other words, parts or subdivisions of the stimulus do not directly control parts or subdivisions of the response (e.g., saying “four” as a response to the question “two times two”).

A common case of intraverbal responding is the ability to verbally classify or categorize objects in the environment, for instance, emitting a sequence of thematically related re-

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Address correspondence to either Caio F. Miguel, The New England Center for Children, 33 Turnpike Rd., Southborough, MA 01772-2108; e-mail: cmiguel@necc.org; or James E. Carr, Department of Psychology, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49008-5439; e-mail: jim.carr@wmich.edu.

sponses such as “piano, drums, flute” when hearing “musical instruments,” or saying “musical instruments” when hearing “piano, drums, flute.”

The “ability to categorize” has been viewed as an essential language skill to be acquired by typically developing individuals (Barsalou, 1992). While interacting with their natural environment, as well as in structured educational activities, children are constantly learning to categorize new objects such as toys, animals, fruits, and musical instruments. Additional evidence for the importance of the emission of thematically related intraverbals is that some intellectual assessments contain subtests related to this repertoire (e.g., McCarthy, 1970). Moreover, intraverbal behavior is considered a prerequisite for more advanced communication skills like conversation, and thus are considered an essential part of curricular programs to teach individuals with developmental disabilities (Sundberg & Partington, 1998). Furthermore, as suggested by Partington and Bailey (1993), many of the skills taught in early childhood education include some form of intraverbal behavior; thus, evaluations of different methods for teaching such behavior appear warranted.

For more than two decades, researchers have studied procedures for teaching intraverbals to individuals with disabilities, as well as typically developing children (e.g., Braam & Poling, 1983; Luciano, 1986; Partington & Bailey, 1993; Watkins, Pack-Teixeira, & Howard, 1989). Braam and Poling evaluated a transfer-of-control procedure to teach thematically related signing responses to individuals diagnosed with mental retardation. During training, participants were presented with a category name, either a single verbal stimulus (e.g., the manual sign “food”) or compound stimuli (e.g., “school people”), and were asked to sign for items that belonged to these categories. If participants responded incorrectly or did not respond, the experimenter provided visual (i.e., tact or textual) prompts (pictures or printed words for the items that belonged to the categories) to occasion the responses. Over time, the prompts were faded so that the responses were under the control of the initial verbal antecedent stimulus. Results from this study suggested that the transfer-of-stimulus-control procedure was effective in teaching thematically related intraverbal signs.

In a follow-up study, Luciano (1986) taught thematically related vocal intraverbals to children diagnosed with mental retardation by using a similar procedure in which stimulus control was transferred from visual (i.e., pictures) to auditory stimuli. A multiple-baseline design across categories was used to assess the effects of training on the number of intraverbal responses given to questions such as, “Tell me the names of foods.” During training, two of the participants were exposed to a prompt delay procedure in which the visual/tact prompt was delayed by zero to one and two seconds from the presentation of the auditory stimulus (category name). The other participant was exposed to a procedure in which the immediate visual/tact prompt was eliminated and an auditory prompt introduced. The experimenter said “say more” after the participant independently emitted a correct response. Both procedures were successful in training intraverbal responses.

Additionally, the author assessed the participants’ listener repertoires before and after intraverbal training. During this assessment, participants were exposed to a receptive discrimination task (referred to as a *comprehensive intraverbal*) in which they were required to select specific cards in the presence of an auditory stimulus (the category name) spoken by the experimenter (e.g., “give me foods”). Data showed that prior to intervention, the participants were able to point to the appropriate objects given the names of some categories, but they were not necessarily able to produce thematically related intraverbal responses. The participants were initially unable to respond receptively to some other category names, but this repertoire emerged following intraverbal training with relevant stimuli, which would suggest some form of interdependence between the listener (receptive) and speaker (intraverbal) repertoires.

Echoic prompts have also been used to teach thematically related intraverbal responses to children diagnosed with mental retardation. Watkins et al. (1989) taught single intraverbal responses belonging to adjective and noun classes (e.g., the response “big” to the stimulus “name a size,” and the response “bear” to the stimulus “name an animal”), as well as multiple intraverbal responses (e.g., the response “big bear” to the stimuli “name a bear”). Echoic prompts consisted of the experimenter

vocally prompting the correct response when participants responded incorrectly or failed to respond within 2 seconds. The echoic prompt procedure was found to be useful in teaching intraverbal responses, especially those involving abstract adjectives difficult to represent in pictures (e.g., soft). Following intraverbal training, participants were exposed to visual stimuli (i.e., pictures or objects depicting the adjective/noun combinations used) to evaluate whether these response topographies would be emitted under tact conditions. Data obtained by Watkins et al. (1989) suggest that intraverbal training did not yield reliable multiple tacts, although most participants were able to produce simple tacts.

Partington and Bailey (1993) were the first researchers to systematically assess the functional independence of tacts and intraverbals. The authors evaluated the effectiveness of a transfer-of-stimulus-control procedure to teach thematically related intraverbal responses to typically developing preschool children. Participants were initially exposed to tact training in which they were required to name five picture cards related to each of the following categories: fruits, toys, things you use to clean the house, and pieces of furniture. Results indicated that tact training did not improve the participants' intraverbal behavior, in this case, their ability to answer questions related to the categories (e.g., "What are some toys?"). This strongly supports the functional independence of these two verbal operants (i.e., tact and intraverbal).

In a second experiment, Partington and Bailey (1993) taught the participants to not only name the item displayed in each picture, but also to name the category to which it belonged (e.g., "This is an *apple* and it's a *fruit*."), a procedure they termed *multiple-tact training*. This procedure may be considered a simple alternative for teaching categories to typically developing children. Partington and Bailey (1993) argued that when participants respond in multiple-tact trials, an intraverbal connection between both tacts (e.g., "apple" and "fruit") may be established. In other words, the response product of the first tact could be established as a verbal stimulus evoking the second response intraverbally. Results indicated that, although the multiple-tact procedure produced intraverbal responding in some children, it was not sufficient to generate consistent re-

sponding across all participants or stimuli. It was not until participants were directly taught intraverbals with a transfer-of-control procedure that they readily acquired the intraverbal repertoire.

Given the importance and ubiquity of intraverbal functions within the verbal repertoire, the relevance of intraverbal behavior to language programming, and the paucity of behavioral research in this area, more research on the topic is clearly needed. The purpose of the current study was (1) to replicate the Partington and Bailey (1993) investigation by evaluating the effects of multiple-tact training on the acquisition of thematically related intraverbals of preschool children, and (2) extend the findings by also assessing the effects of receptive-discrimination training on the acquisition of intraverbals, given that previous research has suggested some interdependence between receptive discrimination of thematically related pictures and thematically related vocal intraverbals (Luciano, 1986). Receptive-discrimination training consisted of a selection response (i.e., selecting a card) in the presence of a specific auditory stimulus that included either the object's name or its category (e.g., "Which one is the *violin*?" or "Which one is the *musical instrument*?"). If neither of the previous training conditions proved to be effective at increasing intraverbals, a transfer of stimulus control procedure to teach intraverbals was employed.

METHOD

Participants, Setting, and Materials

Six typically developing children who attended a local preschool participated in the study. Their ages ranged from 3 yrs., 3 mos. to 5 yrs., 0 mos. at the time they entered the study. Sessions were conducted twice a day (morning and afternoon) in a partitioned area at the preschool and each session lasted approximately 10 min. The experimenters were trained undergraduate psychology students and occasionally one of the first two authors.

The stimuli used during training were 5 cm x 5 cm color photographs of objects on a white background, obtained from the Picture This® CD-ROM. Each picture was encased in a transparent hard plastic cover measuring 7.5 cm x 10 cm. During multiple-tact training (MTT)

and receptive-discrimination training (RDT), either one picture (MTT) or three horizontally aligned pictures (RDT) were presented during a trial. The pictures were attached with Velcro® to a transparent sheet protector with a colored paper insert (i.e., a *trial page*). Trial pages were contained in a 29 cm x 30 cm three-ring binder, and at the completion of each trial, the experimenter flipped the trial page so that the next page became visible. During intraverbal training (IVT), a set of pictures was similarly attached to pages inside the binder, but these pictures were visible only to the experimenter.

Ten pictures of different objects were used as exemplars from each of three categories: *musical instruments* (bells, cymbals, drums, flute, guitar, horn, maracas, piano, tambourine triangle, violin, and xylophone¹), *tools* (drill, hammer, nail, nut, paintbrush, pliers, rake, saw, shovel, and wrench) and *kitchen items* (blender, fork, fridge, knife, microwave, mixer, oven, plate, pot, and turner). Each child received training on two categories, while pictures from the remaining category or another category (i.e., bedroom items) were used as comparison stimuli during RDT and as distracter stimuli during MTT.

At the completion of each session, the child received a snack and/or stickers of his or her own choice for participating in the session; these items were not delivered contingent on performance during the session.

Dependent Variable and Data Collection

The primary dependent variable was the number of correct thematically related intraverbal responses emitted during intraverbal probes. The experimenter recorded all responses on paper and subsequently coded each response as either correct or incorrect. A response was considered correct if it was deemed by the experimenter to be a member of the category specified by the probe question. Data were also collected on the number of new and novel intraverbal responses. A *new intraverbal* was defined as a trained response which had not been emitted in previous probes.

For example, if a child said “screwdriver, wrench” on the first probe for tools, and “screwdriver, hammer, wrench” on the second probe, “hammer” was scored as a new response on the second probe. A *novel intraverbal* was defined as a response that was not included in the training set, but considered to be a member of the category specified by the experimenter.

Interobserver Agreement

A second observer independently recorded data from at least 25% of all intraverbal probes for each participant. Interobserver agreement (IOA) was calculated using the frequency ratio by dividing the smaller number of correct responses recorded during each probe by the larger number of correct responses and multiplying by 100%. Mean IOA was 98% (range, 50% to 100%) for Sarah, 100% for Brandon, 100% for Jane, 100% for Tina, 100% for Martha, and 100% for Cheryl.

A second observer also independently collected data during at least 25% of training sessions for each participant. For each training trial, either an agreement or a disagreement between the two observers was scored. Point-by-point agreement was calculated by dividing the number of agreements by the sum of agreements and disagreements and multiplying by 100%. Mean IOA during training sessions was 99% (range, 76% to 100%) for Sarah, 99% (range, 80% to 100%) for Brandon, 99% (range, 80% to 100%) for Tina, 99% (range, 90% to 100%) for Martha, and 99% (range, 90% to 100%) for Cheryl.

Procedures

Experimental design. A multiple baseline design across two categories was used to evaluate the effects of multiple-tact training (MTT), receptive-discrimination training (RDT) and intraverbal training (IVT; transfer of stimulus control) on thematically related intraverbal responding. Each participant received all three types of training. Three of the children were first exposed to RDT, then MTT, and finally IVT. The remaining three children received MTT, then RDT, and finally IVT.

Intraverbal probes. Each probe began with the experimenter asking, “What are some [category]? Tell me as many as you can.” The child was allowed 10 s to begin responding. If the

¹Only 10 pictures were used. Pictures included in the training set were those of items whose names were not produced intraverbally by the children during baseline probe sessions.

child stopped responding for 10 s, or said, "I don't know," and did not respond for another 10 s, the probe session was terminated. If the same response occurred more than once, only the first instance was counted, but the experimenter waited an additional 10 s for further responses. No consequences were delivered for correct or incorrect responses. Probes were conducted in baseline and following the completion of each training condition (i.e., MTT, RDT, and IVT). Approximately four intraverbal probes were interspersed per session (morning and afternoon). After RDT and MTT, probes were conducted until stability was achieved as determined by visual inspection, or in some cases, until responding had decreased to baseline levels.

Multiple-tact training. In this condition, the children were trained to tact 10 exemplars from a specific category, and then to tact the category to which the exemplars belonged. Training was conducted in two phases. The purpose of Phase I was to train a simple tact of each exemplar. Pictures were presented in 10-trial blocks containing one presentation of each picture, with presentation order varied across blocks. On each trial, the experimenter showed a picture and asked, "What is this?" If the child responded with a correct tact (e.g., "It is a wrench."), the experimenter immediately delivered verbal praise. If the child responded incorrectly or did not respond within 10 s, the experimenter provided an echoic prompt (i.e., said the name of the object) and repeated the question "What is this?" A correct response following a prompt was praised, but the trial was scored as incorrect. Phase I was completed after three consecutive blocks of 100% correct responding.

Phase II was identical to Phase I, except that the target response was a "multiple tact" that included both the name of the exemplar and its category (e.g., "It is a wrench and a tool."). In Phase II, each block of trials consisted of 10 training trials and 5 distracter trials. Distracter trials were identical to training trials, except that the pictures were exemplars of a different category (e.g., bedroom items). The purpose of including distracter trials was to control for echoic responding, because if all trials had consisted of pictures from the same category, a correct response on one trial (e.g., "A wrench and a tool.") could have served as an echoic prompt for the category name on the subse-

quent trial (e.g., "A hammer and a tool."). Phase II training was conducted until participants responded correctly on all training trials for three consecutive trial blocks.

Receptive-discrimination training. In this condition, the children were trained on a receptive discrimination (auditory-visual matching-to-sample) task in which they were asked to select pictures in response to an instruction specifying either the name of the object displayed on the picture or the name of the category to which the picture belonged. Training was conducted in two phases. In Phase I, the children were trained to select a picture from among three comparisons from the same category. Trials were presented in 10-trial blocks in which each picture was targeted once, and presentation order was varied across blocks. A trial began with the experimenter showing a set of pictures and giving the instruction, "Point to the [object]." Correct responses were immediately followed with non-descriptive praise (e.g., "good job," "that's right") after which a new trial was presented. If the child pointed to an incorrect comparison or did not respond within 10 s, the experimenter prompted a correct response by pointing to the correct comparison and then repeated the instruction. A correct response following a prompt was praised, but the trial was scored as incorrect. After three consecutive blocks of 100% correct responding, Phase II commenced. In Phase II, item trials and category trials were interspersed. Item trials were identical to Phase I trials. On category trials, the children were again presented with three comparisons and taught to select the one that belonged to the category specified by the experimenter. The two negative comparisons were pictures of objects belonging to a different category. The instruction consisted of the question, "Point to the [category]," otherwise training was conducted as described in Phase I. Trials were presented in 20-trial blocks. Each picture served as the positive comparison once on an item trial and once on a category trial.

Intraverbal training. During this condition, the children were directly taught to emit appropriate intraverbal responses to a question specifying a category. A trial began with the experimenter asking, "What are some [category]? Tell me as many as you can." All correct responses were immediately praised. If additional responses did not occur within 10s,

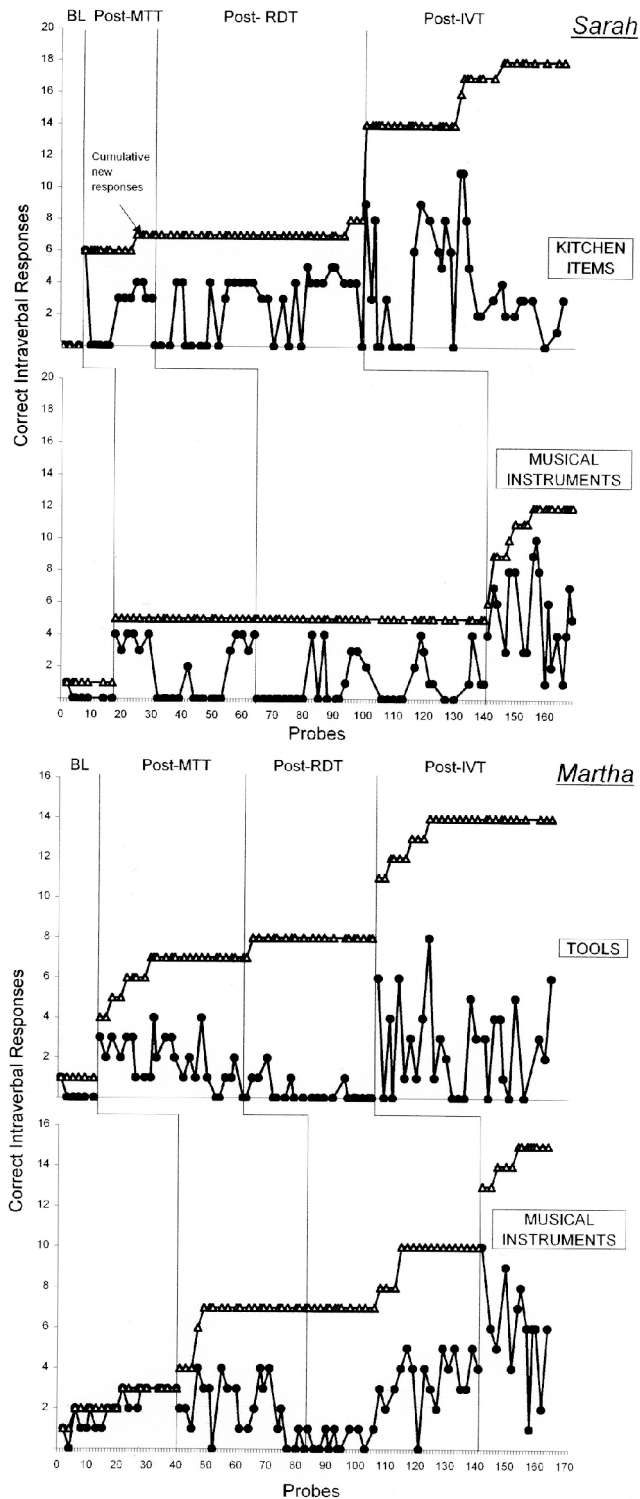


Figure 1. The number of intraverbal responses per probe (filled circles) and the cumulative number of intraverbal responses (open triangles) for Sarah (upper panels) and Martha (lower panels).

the experimenter provided a tact prompt by showing the child one of the pictures from the training set. If the child did not respond to the tact prompt, an echoic prompt was provided. A correct response following a prompt was praised, but the trial was scored as prompted. If the child made an incorrect response, the experimenter said "A [name] is not a [category]" (e.g., "a *flute* is not a *tool*") and then implemented the same prompting procedure. If the child repeated a previous correct response, the experimenter said, "Yes, you already said [name]" and waited 10 s for another response. If the child made a response that was considered correct by the experimenter but was not included in the training set (a novel response), the response was praised and counted among the total number of unprompted responses. A trial was terminated when the participant had emitted all 10 responses in the training set (with or without prompts) and 10 s had elapsed without further responding. Intraverbal training was conducted until participants had made 10 or more unprompted responses on three consecutive training trials. These responses did not have to be part of the training set, as long as they were considered members of the category.

Independent Variable Integrity

Independent variable integrity (IVI) was assessed during at least 25% of all training sessions for each participant by an observer who recorded relevant behaviors of the experimenter. A training trial was scored as correctly implemented if the experimenter gave the correct verbal instruction and implemented the correct consequence for responding; otherwise, it was scored as incorrect. An IVI score was calculated by dividing the number of correctly implemented trials by the total number of trials conducted and multiplying by 100%. Mean IVI scores were 99% (range, 80% to 100%) for Brandon, 100% for Sarah, 99% (range, 90% to 100%) for Jane, 99% (range, 90% to 100%), for Tina, 98% (range, 85% to 100%) for Martha, and 100% for Cheryl.

RESULTS

Sarah, Martha, and Cheryl first received MTT for both categories, then RDT, and finally IVT. For Sarah (upper two panels of Fig-

ure 1), an increase over baseline in intraverbal responding was observed following MTT on both kitchen items (top panel) and musical instruments (lower panel). The number of correct responses produced during probe sessions was highly variable in both categories. Following MTT, Sarah produced a total of seven unique responses on kitchen items and a total of five unique responses on musical instruments (see cumulative data path). RDT resulted in similar effects for both categories—variable and low levels of responding. Novel responses (not included in the training set) did not occur for either category following RDT. IVT resulted in an increase in number of responses emitted per probe compared to MTT and RDT, and a large increase in the cumulative number of new (not previously emitted) as well as novel responses in both categories. However, responding remained highly variable across probes, ranging from 0 to 11 correct responses on kitchen items and from 1 to 10 on musical instruments.

Martha's results are depicted in the lower two panels of Figure 1. Following MTT of tools, Martha's intraverbal responding immediately increased but then decreased across subsequent probes. She produced a total of seven unique responses for each category (see cumulative data path). RDT did not result in a recovery of previous levels of responding, and the number of responses continued to decrease across probes. One new response, however, was observed immediately following RDT on the tools category. On musical instruments, intraverbal responding increased somewhat during baseline and stabilized at three responses. Further increases were not reliably observed following MTT, although four new responses occurred. As with tools, the number of responses on musical instruments decreased across probes and initially remained low following RDT. A return to the previous level, and the occurrence of three new responses, however, coincided with the completion of IVT on tools. IVT on both categories resulted in an increase in responding to levels above those previously observed, as well as the occurrence of several novel responses. However, responding again tended to decrease across probes.

For Cheryl (Figure 2), little or no intraverbal responding was observed in either category following both MTT and RDT. Following IVT on tools, reliable increases in the number of

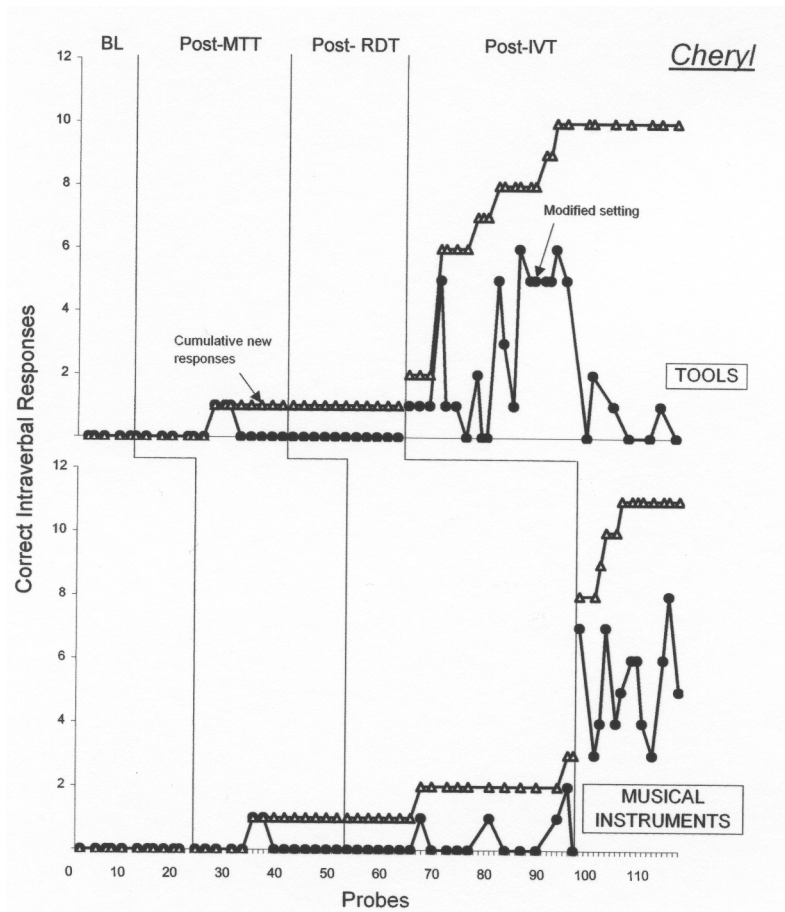


Figure 2. The number of intraverbal responses per probe (filled circles) and the cumulative number of intraverbal responses (open triangles) for Cheryl.

responses per probe were not immediate, but occurred with repeated exposure to probes. After IVT, the number of new responses also increased substantially. Following IVT on musical instruments, an immediate increase in the number of responses per probe as well as the number of new and novel responses was observed.

Tina and Brandon first received RDT on both categories, followed by MTT, and then IVT. Jane received RDT on both categories, followed by MTT on musical instruments, but for reasons unrelated to the study, her participation was terminated before further training could be implemented.

For Brandon (see upper two panels of Figure 3), intraverbal responding increased substantially after RDT on tools, but then decreased across subsequent probes. This effect was not replicated with musical instruments;

only two responses occurred on the first probe following training, and none occurred after that. MTT appeared to have no effect on responding on either category, but an increase in responding on the second category (musical instruments) was later associated with the completion of intraverbal training on the first. IVT produced a clear increase in responding on both categories, although responding decreased over time.

The lower two panels of Figure 3 show Tina's data. Tina emitted no intraverbal responses in baseline and none following RDT on either category. Following MTT, no responding was observed on musical instruments. On tools, no responding occurred immediately following MTT, but a few responses were observed during later probes. As with Brandon, a larger increase in the number of responses per probe as well as the occurrence of new responses and

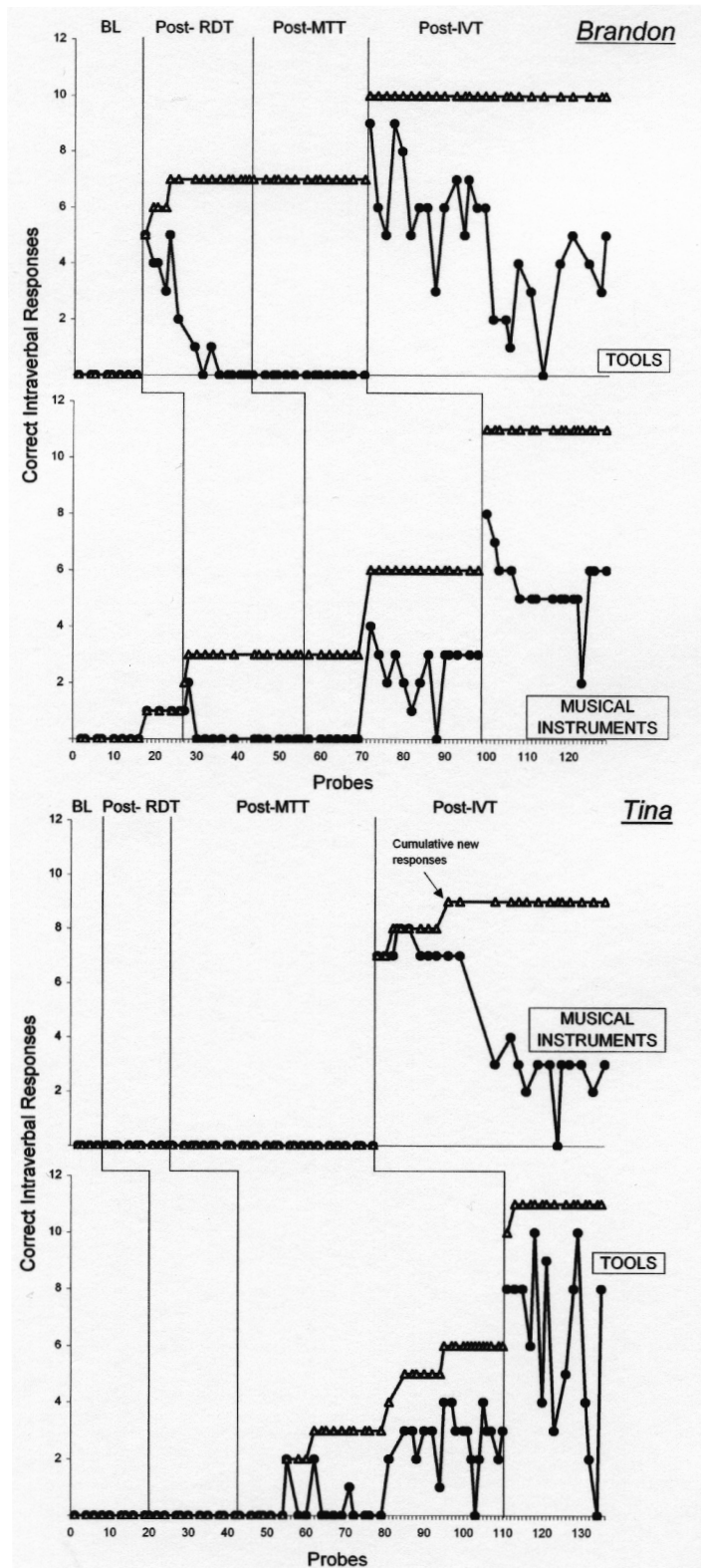


Figure 3. The number of intraverbal responses per probe (filled circles) and the cumulative number of intraverbal responses (open triangles) for Brandon (upper panels) and Tina (lower panels).

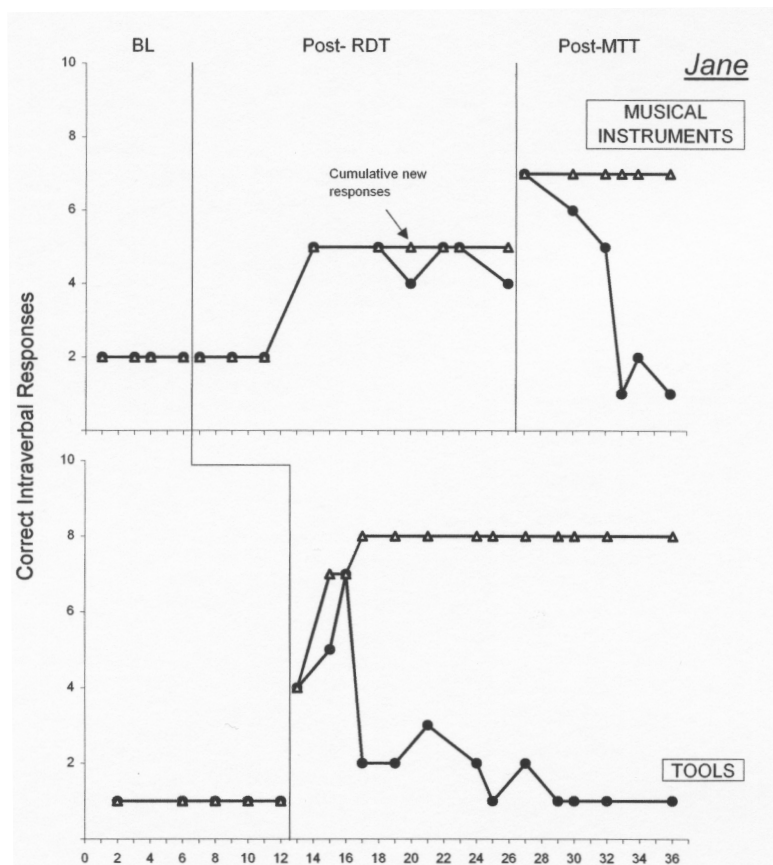


Figure 4. The number of intraverbal responses per probe (filled circles) and the cumulative number of intraverbal responses (open triangles) for Jane.

one novel response coincided with the completion of IVT on musical instruments. Following IVT, intraverbal responding increased substantially in both categories.

For Jane (see Figure 4), no increases in the number of responses per probe were observed initially following RDT on musical instruments; however, two new responses occurred (see cumulative data path). Responding increased further at the time RDT had been completed on the second category (tools). On tools, RDT immediately resulted in a large increase in intraverbal responding, but the increase was not maintained over time. MTT on musical instruments resulted in a slight increase in levels of responding above those previously observed, but responding decreased rapidly across probes.

Figure 5 shows the average number of intraverbals per probe that each participant emitted during each phase. In all cases, direct

training (IVT) produced the most intraverbal responses per probe (with the exception of Jane, who was never exposed to IVT). Both MTT and RDT resulted in fewer intraverbal responses per probe, regardless of the order in which the conditions were presented.

Figure 6 depicts the number of trials participants took to reach criterion in each of the training conditions. Overall, it took longer for participants to reach criterion with MTT and IVT than with RDT. Regardless of the order in which MTT and RDT were presented, in most cases MTT required more trials to criterion.

DISCUSSION

Data from the present study replicate the findings obtained by Partington and Bailey (1993) in that multiple-tact training (MTT) did not yield substantial increases in intraverbal responding. Similarly, in the present study re-

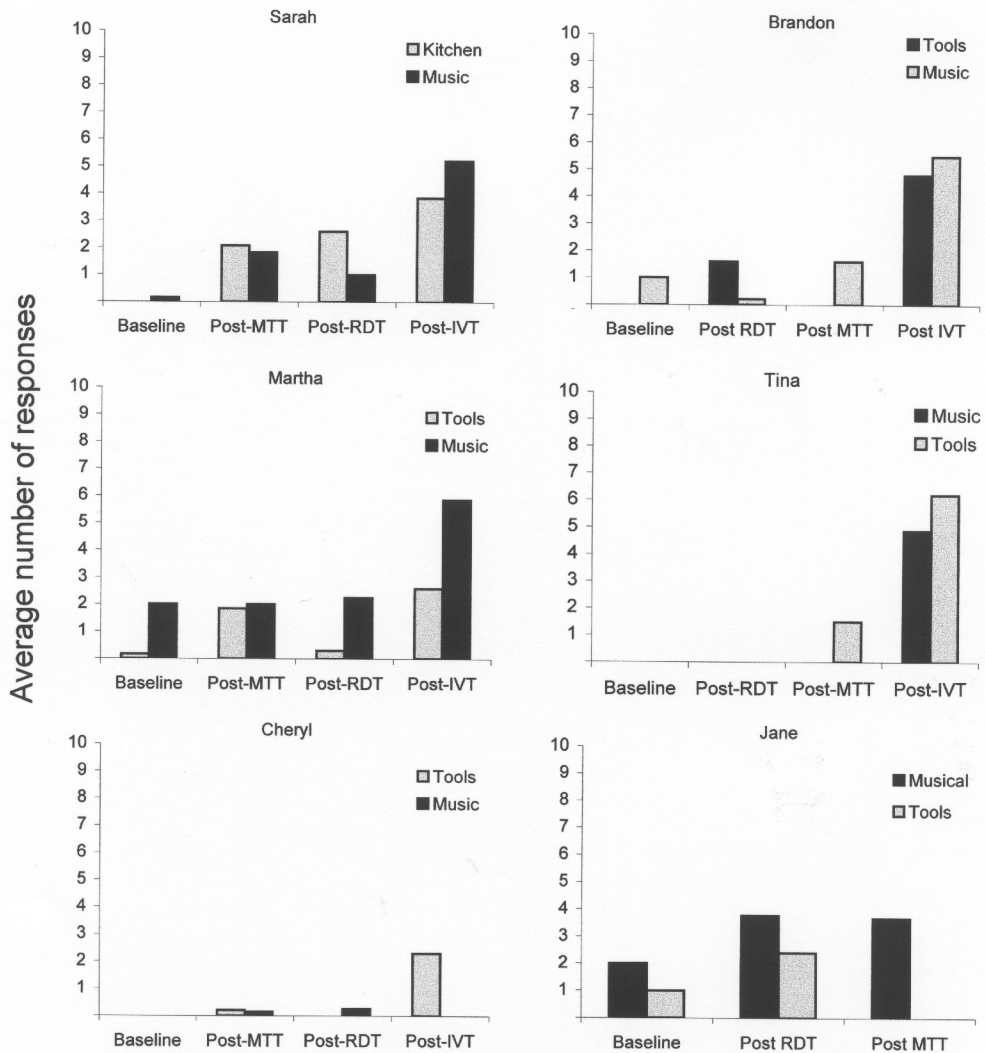


Figure 5. The average number of intraverbal responses per probe after MTT, RDT, and IVT for each participant.

ceptive discrimination training (RDT) seemed to have an equally minor effect on thematically related intraverbal behavior. In summary, while participants were able to (1) tact both the pictures and their categories, and (2) point to the pictures given their names or categories, they were not necessarily able to reliably produce thematically related intraverbal responses. It was only when a transfer-of-stimulus-control procedure (intraverbal training; IVT) was used that substantial increases in intraverbal behavior were seen.

Interestingly, the second intervention did not seem to improve the intraverbal repertoire already acquired after participants were exposed

to the first intervention (for an exception, see the effects of MTT on tools for Tina). It would have been reasonable to assume, for instance, that if intraverbal responding had not improved after children had learned to tact both the items and their categories, that additional training on how to identify pictures based on their names or categories would have strengthened the participants' intraverbal repertoire. A possible interpretation based on derived stimulus relations (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000; Hayes, Barnes-Holmes, & Roche, 2001) may have predicted this outcome. It may be possible to characterize the different stimuli and response forms, namely, the picture (A), its

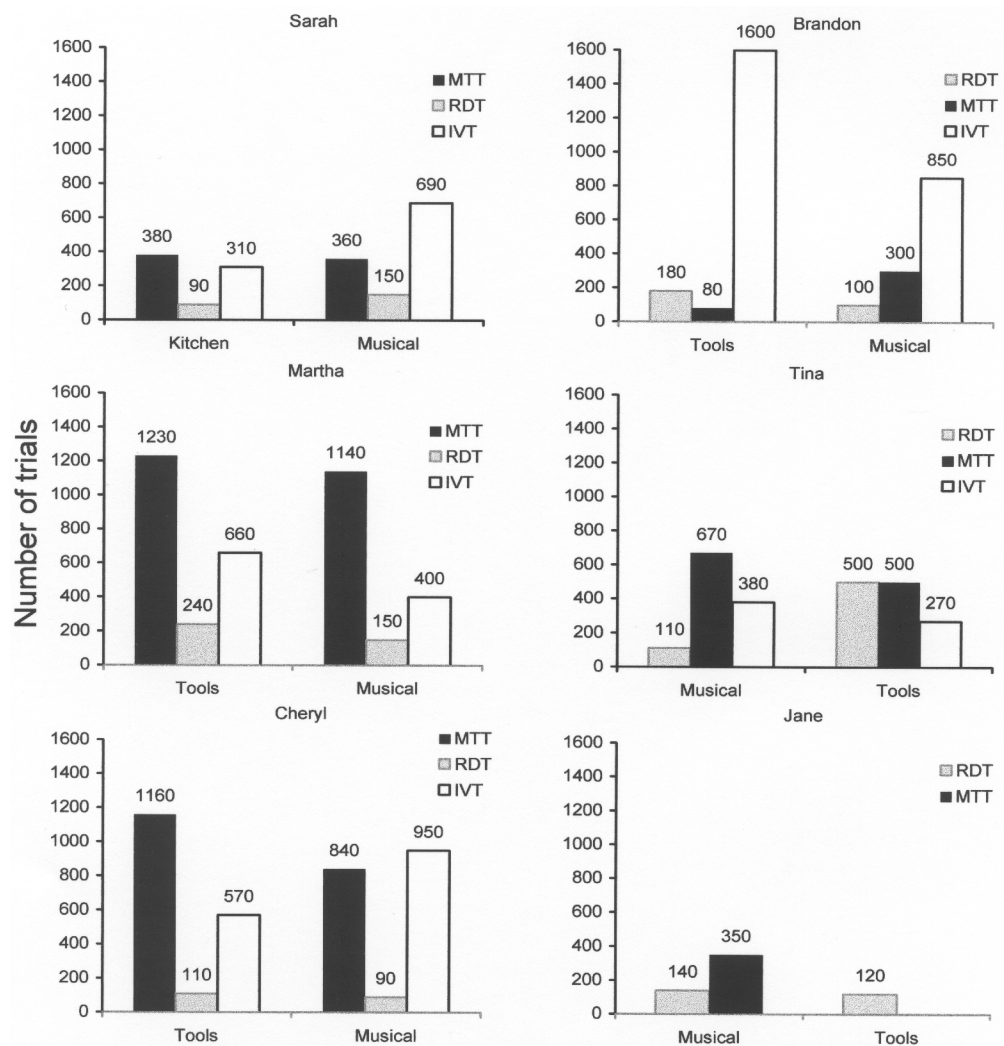


Figure 6. The number of trials to criterion in each training phase.

name (B), and its category (C) as related to each other as members of the same class. In this case, during RDT, a picture (A) served as a positive comparison in the presence of two sample auditory stimuli: the picture's name (B) and its category (C). Thus, during RDT the conditional relations BA and CA were directly reinforced for all 10 different pictures. Intraverbal behavior would have consisted of the emission of the vocal response (B) in the presence of the auditory stimulus (C), the transitive CB relation. As observed in the results, the emergence of this untrained relation was weak. When the second intervention was introduced, for instance, MTT, the symmetrical relations AB and AC were directly reinforced. In this case, cor-

rect vocal responses, either the name or the category were reinforced in the presence of a picture, the sample visual stimulus. This additional symmetrical training did not improve the participants' intraverbal repertoire (i.e., did not strengthen the CB relation).

Although plausible, a derived stimulus relation interpretation of the procedures may be limited by the fact that the trained relations were not comparable (see Hall & Chase, 1991). During RDT, the BA and CA relations consisted of a series of conditional discriminations, in which a sample auditory stimulus (the name of the picture or its category) strengthened the evocative function of the correct comparison (the picture) for a selection response. However,

during MTT, the AB and AC relations consisted of a series of simple discrimination tasks in which a visual stimulus (the picture) directly evoked two different response forms (the name of the picture or the name of its category). Furthermore, intraverbal probes (CB) also consisted of a simple discrimination involving an auditory stimulus (the name of the category) and a vocal response (the name of the picture). Typically, positive outcomes on derived stimulus relations/equivalence research are observed after baseline training on conditional discrimination tasks (in matching-to-sample format) involving selection responses (Green & Saunders, 1998). Additionally, only one class/concept/theme was trained at a time, and the number of visual stimuli used was exceptionally large, as was the number of intraverbal responses required during probes. Future research should attempt to better unite the methods resulting from the stimulus equivalence/derived stimulus relations and verbal behavior literatures to understand verbal behavior (e.g., intraverbal) that has not been explicitly trained. Such synthesis can only strengthen the behavior-analytic research agenda for the study of language (Barnes-Holmes et al., 2000).

Results seem to be in line with Skinner's (1957) analysis of verbal behavior that would predict functional independence of the verbal relations trained and tested. These relations were comprised of separate operants, controlled by distinct antecedent variables, sometimes verbal + nonverbal (RDT) and sometimes non-verbal (MTT) discriminative stimuli. Some of the transfer observed from tacts to intraverbals, for example, could be explained by the fact that during MTT children were required to tact both the item and its category (e.g., say "pliers and tool"). This "contiguous usage" (Skinner, 1957, p. 75) may have contributed to the tendency to say "pliers" when the child heard "tool." During RDT, the children were required to select pictures after being presented with an auditory stimulus. It is quite possible that during training they were covertly echoing the auditory stimulus produced by the experimenter from trial to trial (e.g., "pliers" and "tools"). This repetition would have qualified as a form of covert contiguous usage, facilitating the emergence of intraverbal behavior after receptive training. Future research should investigate whether transfer between repertoires would occur when

individuals with a more limited verbal repertoire are exposed to similar procedures.

The fact that participants took longer to reach training criterion on MTT and IVT than on RDT seems consistent with the literature on language acquisition that suggests that receptive language skills are mastered before expressive (e.g., Fraser, Bellugi, & Brown, 1963). Although training one repertoire may have facilitated the acquisition of the other (subsequent one), there was no clear transfer between repertoires. For instance, a similar number of trials were necessary for participants to reach criterion on RDT, regardless of the order in which this intervention was presented. This may suggest that MTT had little impact on the acquisition of receptive behavior; however, it may also have been a ceiling effect due to the fact that most participants reached criterion quickly in RDT and in fact responded correctly on the majority of all trials the first time that they were presented. On the other hand, RDT may have facilitated the acquisition of tacts (see Figure 6) given that the participants who were first exposed to RDT required fewer trials to master MTT than those who were initially exposed to this condition. So far, data on the transfer between listener/receptive and speaker/expressive repertoires have been equivocal (Wynn & Smith, 2003), and results obtained in the current study are no exception.

The results from the current study may suggest directions for designing curricula for teaching verbal behavior. Both receptive-discrimination and multiple-tact training produced weak changes in the intraverbal repertoires of typically developing, language-capable preschool children. It was not until a transfer-of-control procedure was used to directly teach intraverbals that this behavior substantially increased. It may be safe to assume that when teaching intraverbal behavior to less capable children, for instance, children diagnosed with language delays or developmental disabilities, a transfer-of-control procedure should be the intervention of choice. However, before any clear suggestions can be made, more research is warranted. Given that some generalization from the trained to the untrained repertoire was seen, future researchers may want to evaluate whether a history with either receptive discrimination or tact training would impact the acquisition of vocal intraverbals.

Additionally, it may be important to assess

whether multiple-tact and receptive-discrimination training would facilitate the development of other forms of categorization, such as picture sorting. It has been previously suggested that the development of arbitrary stimulus classes/categorization may depend upon the ability to tact and receptively discriminate objects (Horne & Lowe, 1996). Recent studies (Horne, Lowe, & Randle, 2004; Lowe, Horne, Harris, & Randle, 2002; Miguel, Petursdottir, Carr, & Michael, 2005) have shown that when presented with an array of arbitrary objects or pictures belonging to two experimenter-defined classes, typically developing children can sort these objects/pictures (i.e., categorize) without direct training when able to: 1) tact them using a common name (the name of the class to which they belong), and 2) select them when hearing their common names. Future researchers should attempt to contribute to the applied literature by evaluating whether tact and/or receptive discrimination training could be used to develop skills such as picture sorting in developmentally disabled children.

Some limitations of the current study are worth noting. First, the extreme variation in the frequency of responses, as well as the decreasing trends observed across probe sessions could have been due to the unavailability of reinforcement. Replications should attempt to diminish the discriminability between training and testing. The extreme variation and decreasing trends observed after IVT training may suggest that even the direct intervention to teach intraverbals was not sufficiently powerful to produce sustained increases in correct responding. However, in the natural environment social reinforcement would most likely be delivered for children's correct maintenance responses.

Second, for some participants, the increase in responding during probe sessions for one category coincided with the completion of intraverbal training in the other category, thus confounding some of the results. Noteworthy, during MTT and RDT, participants were required to produce two vocal topographies and a selection response, respectively. When first introduced to IVT, participants were suddenly prompted and reinforced to produce a series of vocal topographies (i.e., thematically related responses). This contingency may have established the experimenter as a discriminative stimulus associated with the availability of re-

inforcement for a sequence of vocal responses. Given that the experimenter was present during all probe sessions, it is not surprising that after being exposed to IVT on the first category, children started to produce a sequence of responses when probed on the second category as well.

If the above interpretation is correct, replications should guarantee a history of reinforcement for sequences of responses. This can be done by providing reinforcement during probes. Maybe children such as Brandon, Tina, Martha, and Sarah would have not required intraverbal training after being exposed to MTT and/or RDT had the contingencies present during probe sessions been different.

It is important to note that the purpose of the study was primarily to evaluate the effects of different procedures, which may be used by practitioners, to teach children with language delays (e.g., Sundberg & Partington, 1998). Because participants in the current study are not characterized as the ones who would generally receive this type of intervention, the study may be best characterized as a "bridge" between basic and applied research (Wacker, 1996). Given that empirical research in the area of verbal behavior is lacking (Normand, Fossa, & Poling, 2000) experimental demonstrations of some of the teaching techniques based on verbal behavior may be necessary before extensive recommendations can be made.

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